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Internet of Things in Healthcare Applications

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Abstract

The fields of computer science and electronics arecombined to result one of the most prominent technological advances in the form of realization of the Internet of Things.Among many of applications enabled by the Internet of Things (IoT), smart and connected health care is a particularly important one. IoT eliminates distance barriers and can improve access to medical services that would often not be consistently available in distant rural communities.The impact of IoT in healthcare, although still in its early stages of development has been significant. Networked sensors, either worn on the body or embedded in our living environments, make possible the gathering of good information indicative of our physical and mental health. This paper tries to review and comprehend the applications of IoT in custom-made healthcare to achieve excellent healthcare at affordable costs. We have explained in brief what IoT is, how it functions and how it is used in combination with wireless and sensing techniques to implement the desired healthcare applications. Here, we highlighted the opportunities and challenges for IoT in realizing the vision of the future of health care.

Keywords— *Internet of things, healthcare, remote health monitoring, wireless sensor networks etc.*

Introduction

In the current technology empowered world, changes are rapid and the status-quo isconstantly disrupted. Internet of Things (IoT) is one such disruption happening rightnow, which has the potential to change the way healthcare is delivered. There are nocustomary definitions for the Internet of things, As per the definition of Gartner ,"Internet of Things (IoT) is the network of physical objects that contain embeddedtechnology to communicate and sense or interact with their internal states or theexternal environment".

The term Internet talk about to wide category of applications and protocols built on top of refined and interconnected computer networks, serving trillions of users around the world round the clock. Infact, we are at the beginning of an emerging era where global communication and connectivity is neither a dream nor a challenge anymore. Consequently,

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the focus has shifted toward a one-piece integration of people and devices to converge the physical realm with human made virtual environment, creating the so called Internet of Things.

This phenomena reveals two important pillars of IoT i.e., Internet and Things, which require more clarification. Every object capable of connecting to the Internet will fall into the "Things" category which includes the generic entities like smart devices, sensors, human beings and other objects which able to communicate with other entities and accessible anytime, anywhere

The main contributor for the IoT can be attributed tothe growth of smart phones and tablets. These mobile devices act as a window to theIoT world. They have the capabilities to perform the wide variety of tasks for the patient& doctors, in addition to providing mobility and connectivity. The mobile revolution ispushing the connectivity of other physical objects seamlessly using the cloud storage.As more and more devices are connecting and communicating with each other, hugevolume of data is exchanged. This explosion of data needs to be stored, analyzed withcomplex data analytic techniques to provide the necessary information for both thepatient and doctor. However, in the current trend, only the medical devices within thehospital infrastructure are connected within themselves and this network providesaccess through medical apps available to the clinicians.

Evolution of IoT

In 2008 the number of things connected to the Internet was greater than the people living on Earth.Within 2020 the number of things connected to the Internet will be about 50 billion. In the IoT, 'things' are expected to become active participants in business, information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information 'sensed' about the environment, while reacting autonomously to the 'real/physical world' events and influencing it by running processes that trigger actions and create services with or without direct human intervention. Interfaces in the form of services facilitate interactions with these 'smart things' over the Internet, query and change their state and any information associated with them, taking into account security and privacy issues.The internet of things (IoT) is the internetworking of physical devices, vehicles, buildings and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to

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collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society".

The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. The availability of data till now at unimagined scales and temporal longitudes coupled with a new generation of intelligent processing algorithms can: (a) facilitate an evolution in the practice of medicine, from the current post facto diagnose-andtreat reactive paradigm, to a proactive framework for prognosis of diseases at an incipient stage, coupled with prevention, cure, and overall management of health instead of disease, (b) enable personalization of treatment and management options targeted particularly to the specific circumstances and needs of the individual, and (c) help reduce the cost of health care while simultaneously improving outcomes. [6] discussed about a method, In vehicular ad hoc networks (VANETs), because of the nonexistence of end-to-end connections, it is essential that nodes take advantage of connection opportunities to forward messages to make end-to-end messaging possible. Thus, it is crucial to make sure that nodes have incentives to forward messages for others, despite the fact that the routing protocols in VANETs are different from traditional end-to-end routing protocols. In this paper, stimulation of message forwarding in VANETs is concerned. This approach is based on coalitional game theory, particularly, an incentive scheme for VANETs is proposed and with this scheme, following the routing protocol is in the best interest of each node. In addition, a lightweight approach is proposed for taking the limited storage space of each node into consideration.

Definitions

As per Wikipedia….The Internet of Things, also called The Internet of Objects, refers to a wireless network between objects, usually the network will be wireless and self-configuring, such as household appliances.

As per Wikipedia…. By embedding short-range mobile transceivers into a wide array of additional gadgets and everyday items, enabling new forms of communication between people and things, and between things themselves.

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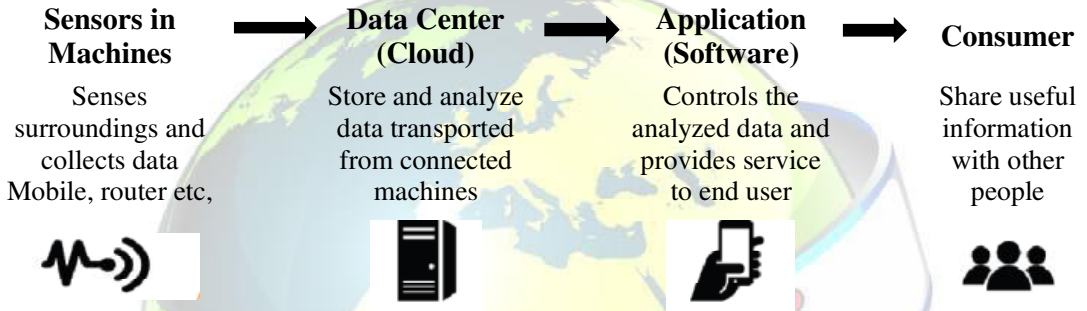
IoT in 2008 …… The term "Internet of Things" has come to describe a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects.

IoT in 2020 …… "Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts".

Internet of Things (IoT): Data Flow

Data Flow in IoT is given by the following chart, which illustrates the data transformation from a smart object to the end user consumers



Structure of IoT – Enabling Technologies

The Internet of Things is to connect physical objects over an IP or other network, to exchange/store/collect information to consumers and businesses via a software application. Nearly every person has encountered or used a particular IoT application with 4.9 billion predicted to be connected through 2016. Through this phenomenon, new market opportunities have formed with industries harnessing the IoT potential to further benefit consumers or companies and gain a competitive advantage.

Initially, Radio Frequency Identification (RFID) used to be the governing technology behind IoT development, but with further technological developments, Wireless Sensor Networks (WSN) and Bluetooth enabled devices augmented the mainstream adoption of IoT trend.

Applications of IoT

The ability to network embedded devices with limited CPU, memory and power resources means that IoT finds applications in nearly every field.IoT systems are responsible for performing actions, not just sensing things. Some examples of IoT applications are:*Intelligent shopping systems*, which can monitor specific users' purchasing habits in a

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store by tracking their specific mobile phones. These users could then be provided with special offers on their favorite products, or even location of items that they need, which their fridge has automatically conveyed to the phone.Applications that deal with heat, electricity and energy management, as well as cruise-assisting transportation systems.Enabling extended home security features and home automation.To describe networks of biological sensors that could use cloud-based analyses to allow users to study DNA or other molecules.With IoT, we can control the electrical devices installed in our house while we are sorting out our files in office. Water will be warm as soon as we get up in the morning for the shower. Entire credit goes to smart devices which make up the smart home.

However, the application of the IoT is not only restricted to these areas. Other specialized use cases of the IoT may also exist. An overview of some of the most prominent application areas is provided here. Based on the application domain, IoT products can be classified broadly into five different categories: smart wearable, smart home, smart city, smart environment, and smart enterprise. There are numerous applications of IoT in many fields. In this paper, we are attempting the IoT applications in Telemedicine, which is gaining importance day by day in healthcare.

IoT in Healthcare of Human beings

The current trends in the healthcare can be classified in multiple ways based on theperspective of the technology, functionality and the benefits. There is a trend happeningwith the convergence of consumer devices and medical devices. Most recentsmartphones are being launched with health sensors in the accessories like wrist gear.This enables the mHealth, which refers to the use of mobile and wireless technologiesin the practice of medicine and the monitoring of public health. This reduces medicalerrors based on continual monitoring practices. IoT applications in healthcare can begrouped into 3 categories based on the functionality, i.e., Tracking of objects and people, identification and authentication and Automatic data collection and sensing.

IoT devices can be used to enable remote health monitoring and emergency notification systems. These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized implants, such as pacemakers, Fitbit electronic wristbands or advanced hearing aids. Specialized sensors can also be equipped within living spaces to monitor the health and general well-being of senior

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citizens, while also ensuring that proper treatment is being administered and assisting people regain lost mobility via therapy as well.More and more end-to-end health monitoring IoT platforms are coming up for antenatal and chronic patients, helping one manage health vitals and recurring medication requirements.IoT in Healthcare is a heterogeneous computing, wirelessly communicating system of apps and devices that connects patients and health providers to diagnose, monitor, track and store vital statistics and medical information. Two important phases of IoT applications in Healthcare

IOT Healthcare solutions can remotely monitor patients suffering from cardiac, diabetes, arrhythmia and chronic diseases, GPS tracking of dementia and Alzheimer's sufferers. Put life-saving data, such as CT scans, test results and patient records, into the hands of medical staff, almost anytime

Few examples of IoT in Healthcare

- Headsets that measure brainwaves, Clothes with sensing devices, BP monitors
- Glucose monitors, ECG monitors, Pulse oximeters
- Sensors embedded in medical equipment, dispensing systems, surgical robots and device implants
- Any wearable technology device……..

Conclusions

As discussed in this paper, all the physical objects will work seamlessly with machineto-machineand human-to-machine interfaces. This level of interconnection is a boon forthe healthcare, where health influencing factors both internal & external to the humanbody can be analyzed based on the model. As the examples in this paper make clear, the longpredicted IoT revolution in healthcare is already underway. And, as new use cases are emerging, they continue to address the urgent need for affordable, accessible care. Meanwhile, the IoT building blocks of automation and machine-to-machine communication continue to be established. The addition of the service layer forms the complete IoT infrastructure. This revolution is characterized by providing end-to-end processing and connectivity solutions for IoT-driven healthcare.This mobile doctor buddy apps are not meant to be the replacement forexperience of the doctors. They should work collaboratively with the doctor. In thisapproach of complementing the doctor with the technology based inputs, the new trendsin IoT has the capability to transform the way the primary healthcare is delivered

to thepatients. However for the developing world, IoT brings new delivery model forhealthcare with good quality at affordable level. It is evident that IoT willfacilitate new business models and new healthcare delivery models in the future for bothdeveloping and developed worlds, irrespective of the challenges faced at the currenttime.

In this paper, we reviewed the current state and projected future directions for integration of remote health monitoring technologies into the clinical practice of medicine. Wearable sensors, particularly those equipped with IoT intelligence, offer attractive options for enabling observation and recording of data in home and work environments, over much longer durations than are currently done at office and laboratory visits. This treasure trove of data, when analyzed and presented to physicians in easy-to-assimilate visualizations has the potential for radically improving healthcare and reducing costs.

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